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Floristic composition of a Neotropical inselberg from Espírito Santo state, Brazil: an important area for conservation

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Abstract: Our study on granitic and gneissic rock outcrops on Pedra dos Pontões in Espírito Santo state contributes to the knowledge of the vascular flora of inselbergs in southeastern Brazil. We registered 211 species distributed among 51 families and 130 genera. Orchidaceae, Bromeliaceae and Polypodiaceae were the most representative families. Concerning vegetative habit, herbs were predominant and about the preference for substrates, holorupicolous species and epiphytes were most speciose. The richest rocky habitat type was woody thicket, with 122 exclusive species. In total, 27 of the species registered in our study are cited on official lists of endangered plant species from Espírito Santo state and Brazil. In addition, two new records of angiosperms for Espírito Santo flora and two new species were recorded for the area. Our data demonstrates the importance of the area for conservation of unique biodiversity that serves as a sanctuary for a rich rupicolous flora composed of endemic and endangered species, some of which are new to science.

Key words: Atlantic Rainforest; conservation; vegetation island; Pedra dos Pontões; rocky outcrops; taxonomy

INTRODUCTION

The rocky outcrops or inselbergs (from German, *insel* = island, *berg* = mountain) are landscape elements consisting mainly of granitic and gneissic rocks, which abruptly stand out amid a predominantly flat landscape (Bremer & Sander 2000). However, in floristic and ecological terms, inselberg refers to all granitic and gneissic rock outcrops, which are home to a specific, distinct type of vegetation different from that of the surroundings (Burke 2003; Barbará et al. 2009; Couto et al. 2016; Manhães et al. 2016).

Inselbergs form isolated ecosystems possessing strong environmental filters (e.g., total or partial absence of soil, low water retention, nutrient scarcity, difficulty in affixing roots, exposure to wind and heat) that allow these areas to support a highly specialized flora with sometimes high levels of diversity and endemism (Larson et al. 2000; Porembski & Barthlott 2000; Porembski 2007).

Among the major regions recognized worldwide for this type of vegetation, southeastern Brazil stands out (Porembski 2007). In this context, the inselbergs situated in southern portion of Espírito Santo state are worth mentioning, recognized by Martinelli (2007) as a priority area for floristic studies and the creation of protected areas. This fact demonstrates the need for a greater effort for recording the biodiversity of these environments, as knowledge of this biota is essential for proposing actions for their management, use, restoration, and conservation.

Floristic inventories carried out on inselbergs in Espírito Santo are scarce. One study worth mentioning is Esgario et al. (2009) survey of inselbergs at Alto Misterioso, in mid-west region of Espírito Santo, where 172 species, including 10 new to science, were recorded.

Thus, the goal of this current study is to present for the first time a list of vascular plants that grow on rocky outcrops of Pedra dos Pontões, Mimoso do Sul, and to document occurrence of endemic and endangered species in order to reinforce the need for preservation of this priority area for conservation within Espírito Santo.

MATERIAL AND METHODS

Study site

Pedra dos Pontões (20°56′43″ S – 20°56′27″ S, 041°32′21″ W – 041°34′05″ W, WGS84) is a montane inselberg (Couto et al. 2016) located in Mimoso do Sul municipality, in

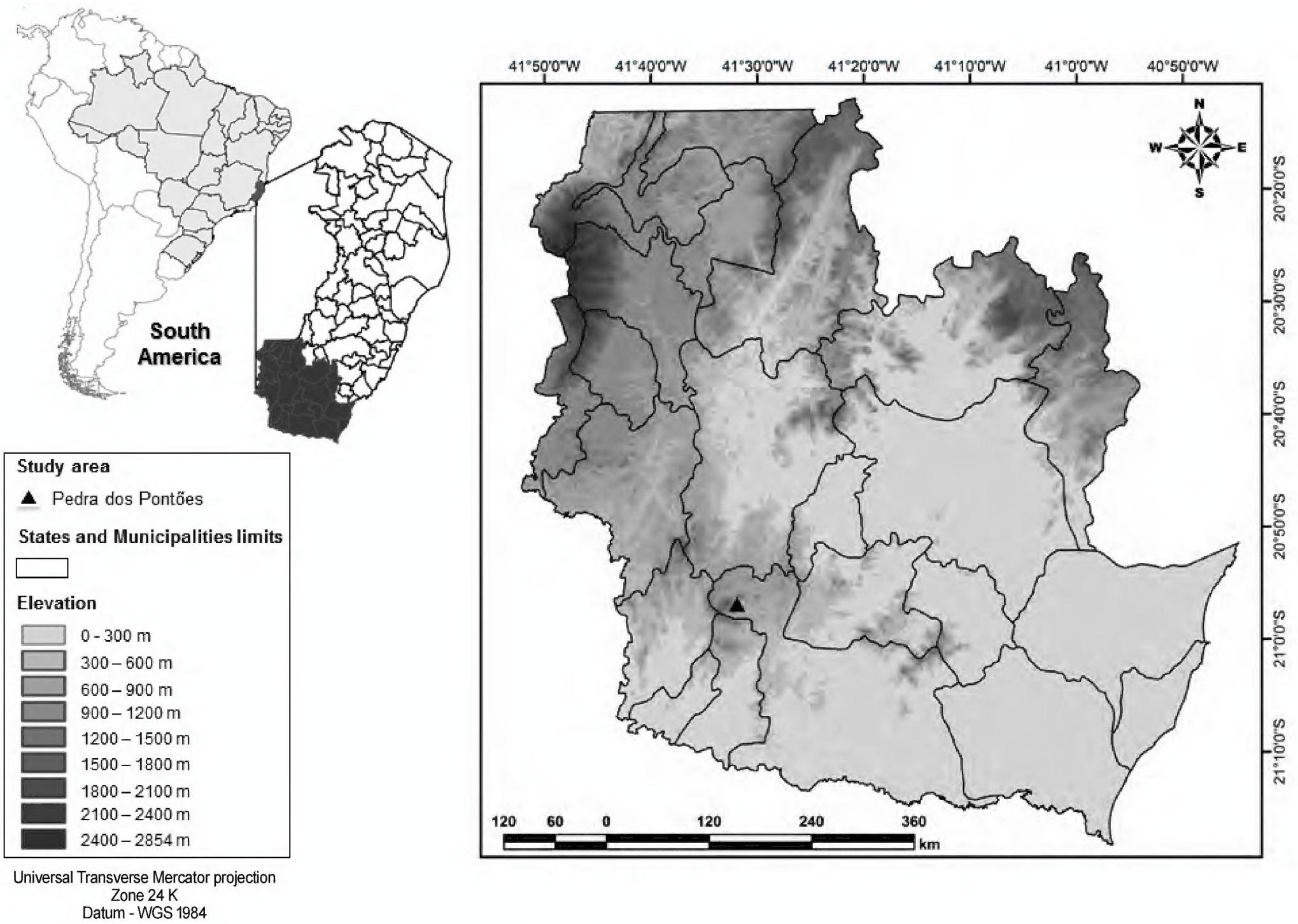


Figure 1. Location map of Pedra dos Pontões, Mimoso do Sul, Espírito Santo state, Brazil.

the southern portion of Espírito Santo (Figure 1). It is well known for its scenic beauty, standing out from the landscape where it can be seen for tens of kilometers, even though set in a mountainous region, typical of the region.

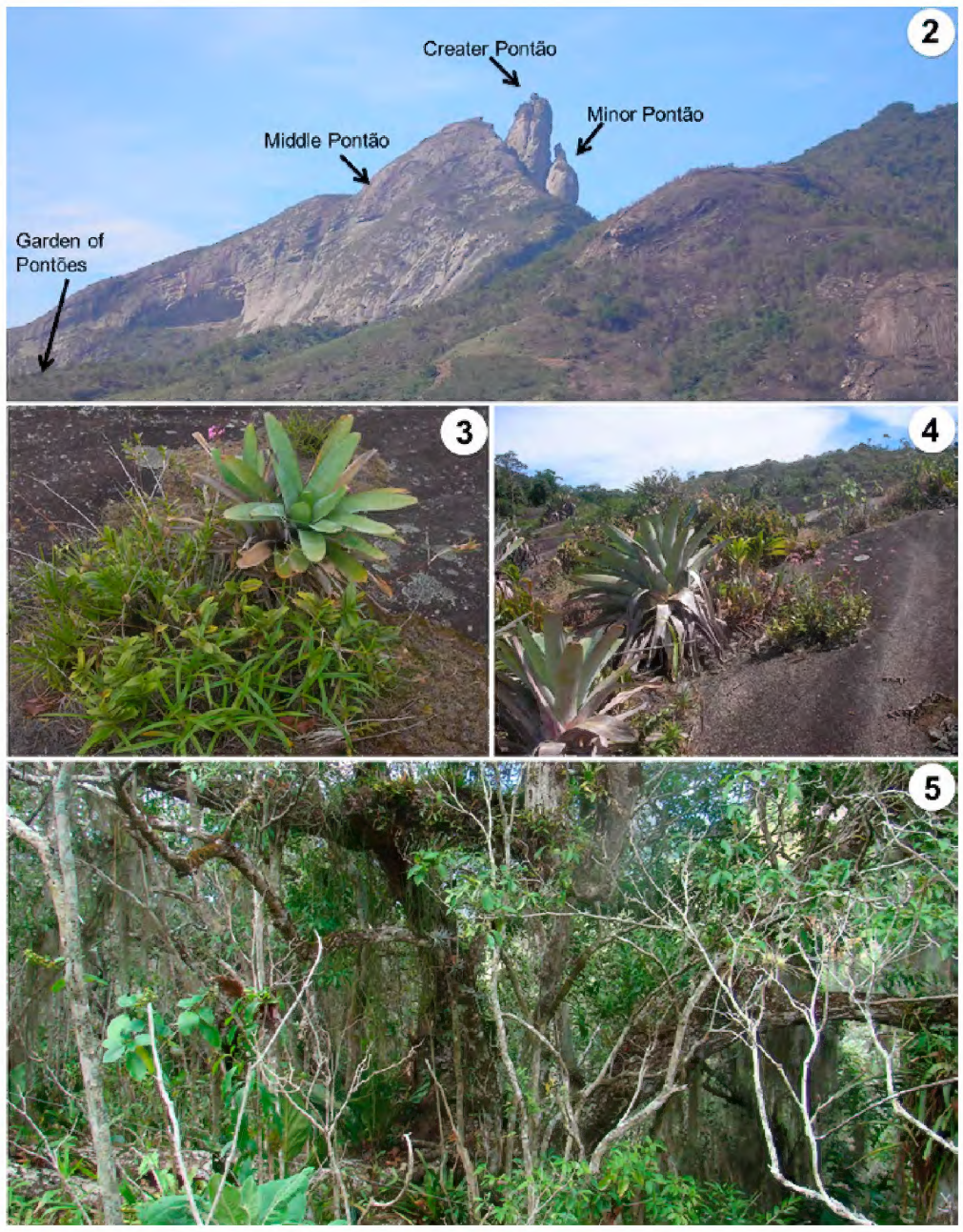
The site covers approximately 350 ha with an altitude gradient ranging from 700 to 1400 m (Couto et al. 2013). The vegetation cover consists of a mosaic of rock outcrops and forest vegetation in a transition area between seasonal semideciduous montane forest and dense rainforest (Couto et al. 2016). These native vegetation are inserted in an anthropogenic matrix mainly developed for agricultural activities on small, family-operated, rural farms, where the main activity is cultivation of mountain-grown coffee (*Coffea arabica* L.), interspersed with fruit-growing (banana), monoculture of eucalyptus and small areas intended for raising livestock (Couto et al. 2013). This is also an important area for recharging water to the Muqui do Sul River hydrographic micro-basin, a contributor to the Itabapoana basin, which supplies water to hundreds of rural properties in Mimoso do Sul municipality.

The climate of the region, according to Köppen classification, is type Cwb (subtropical, moderately humid), mesothermal humid, with rainy summers and dry winters, water deficit during the period from May to September (cold, dry season) and a precipitation surplus between December and March (hot, rainy season). The average annual rainfall (based on 30 years of historical data) is 1,375 mm with an average temperature of 21°C (Couto et al. 2016).

The inselbergs' vegetation is well preserved, with four major sectors being recognized (Figure 2): sector 1 — Garden of Pontões (Jardim dos Pontões): composed of more flat and undulating areas with the presence of some cavities (caves) and high inaccessible cliffs; sector 2 — Middle Pontão (Pontão Médio): in this sector a greater diversity of habitats can be found, from corrugated to fully vertical rock faces, where access is possible by difficult hikes or climbs with optional use of rock climbing equipment; sector 3 — Minor Pontão (Pontão Menor); and sector 4 — Higher Pontão (Pontão Maior): these two sectors are represented by large vertical cliffs over 300 m in height where access is only possible through the use of rock climbing techniques and equipment (Figure 2). The current study was conducted only in sectors 1 and 2, where access is easier and there is a larger area of exposed rocky outcrops.

Data collection

Collection of botanical specimens was conducted between 2004 and 2012. Fertile specimens were collected and subsequently herborized, according to the standard procedures used in floristic surveys (Mori et al. 1989). Vouchers



Figures 2–5. Environments of the studied area in Pedra dos Pontões, Mimoso do Sul, Espírito Santo, Brazil. **2.** *Inselberg* Pedra dos Pontões, showing the observed sectors. **3–4.** Aspects of the islands of herbaceous habitat with the presence of important floristic elements in these environments such as Bromeliaceae, Orchidaceae and Velloziaceae. **5.** Woody thickets, demonstrating the abundant presence of woody elements and a rich vascular flora. Photos by D.R. Couto.

were deposited in the Herbarium at the Professor Mello Leitão Museum of Biology (MBML) and in the Herbarium at the Federal University of ES (VIES subcuration Alegre/ Jeronimo Monteiro). Duplicates were sent to the Herbaria RB, R, HUEFS, UFRN, VIC and SP, acronyms as listed in the Herbarium Index (Thiers 2015). List was complemented with existing data from other projects conducted at the same location (Couto 2013; Couto et al. 2013, 2016).

Specimens were identified by the authors using floral taxonomic monographs, comparing with previously identified specimens from MBML, RB, and VIC herbaria and through sending exsiccate to experts in each taxon.

Allocation of species to families followed guidelines set by the APG IV (2016) system for angiosperms, Smith et al. (2006) for ferns and Christenhusz et al. (2011) for lycophytes. Taxonomic names and vegetative habit, if not obtained at the time of collection, were updated according to supplementary materials in BFG (2015) for angiosperms and Prado et al. (2015) for ferns and lycophytes, and using the authors' abbreviations as suggested by Brummitt and Powell (1992) and the International Plant Names Index (2017).

The endangered species were cited according to the official list of endangered species of Brazilian Flora (MMA 2014), and for Espírito Santo follows Espírito Santo (2005) published by the Red List of Flora of ES (Simonelli & Fraga 2007). The exotic species included in the list were categorized according to Moro et al. (2012). Species were classified according to vegetative habit, as trees: woody plant with a single trunk, not branched from the base and which supports the canopy; shrubs: woody plant branched from the base, not forming a defined trunk, and usually with a height exceeding 2 m; subshrubs: low-growing shrub with a height less than to 2 m high; climbing plants: rooted plants without self-supporting capacity, relying on other plants or substrates for supporting them, and presenting different climbing mechanisms and herbaceous: non-lignified plants, which has aspect of herb or grass, opposes a woody vegetable, according to Font Quer (1977) and Gonçalves & Lorenzi (2007).

Species were categorized as having a preference for the following substrates: *Holorupicolous* (or "true rupicolous"): plants living directly on rocky surfaces or on a thin litholitic neosol layer existing over rock; *Epiphytes:* species living on existing vegetation, using haustorial structures; *Hemi-epiphytes*: species that spend only one part in their life as epiphytes. Some species were observed occurring on more than one type of substrate (e.g., epiphytes or rupicolous vegetation) and in this case, plants were classified according to the preferred substrate, that is, the substrate over which species was more frequently found.

All species were organized according to their occupation in different rocky habitat types occurring at the site, without taking into account the microhabitats available on a smaller scale, as those observed by Porembski (2007). In this manner, rocky habitat types were classified into two major groups: *islands of herbaceous vegetation* (Iv; Figures 3 and 4) corresponding to groups of "bushy" plants formed by one or more vascular species distributed directly over a rocky surface, with shallow soil delimited by a rocky surface (Conceição et al. 2007); and *woody thicket* (Tw; Figure 5) corresponding to woody rupicolous communities with occurrence of arboreal and shrubby elements growing directly on the rocky surface, without forming stratification.

RESULTS

A total of 211 vascular plant species were recorded, belonging to 130 genera and 51 families (Table 1 and Figures 6–15). Of the 211 species, only 24 (11%) are identified to genus level, the remainder being identified to species level. Magnoliophyta was represented by 189 species (71 Magnoliopsida and 118 Liliopsida), while ferns by 22 species. Of the recorded species, *Melinis minutiflora* P.Beauv (Poaceae) was classified as invasive species.

The richest families were Orchidaceae (59 species, 28%), Bromeliaceae (35 spp., 17%), Polypodiaceae (13 spp., 6%), Cactaceae and Araceae (8 spp. each, 8%) and Piperaceae (7 spp., 3%) containing 62% of the recorded species (Table 1). Species distribution within the remaining families was unequal, with over half (28 families, 55%) being

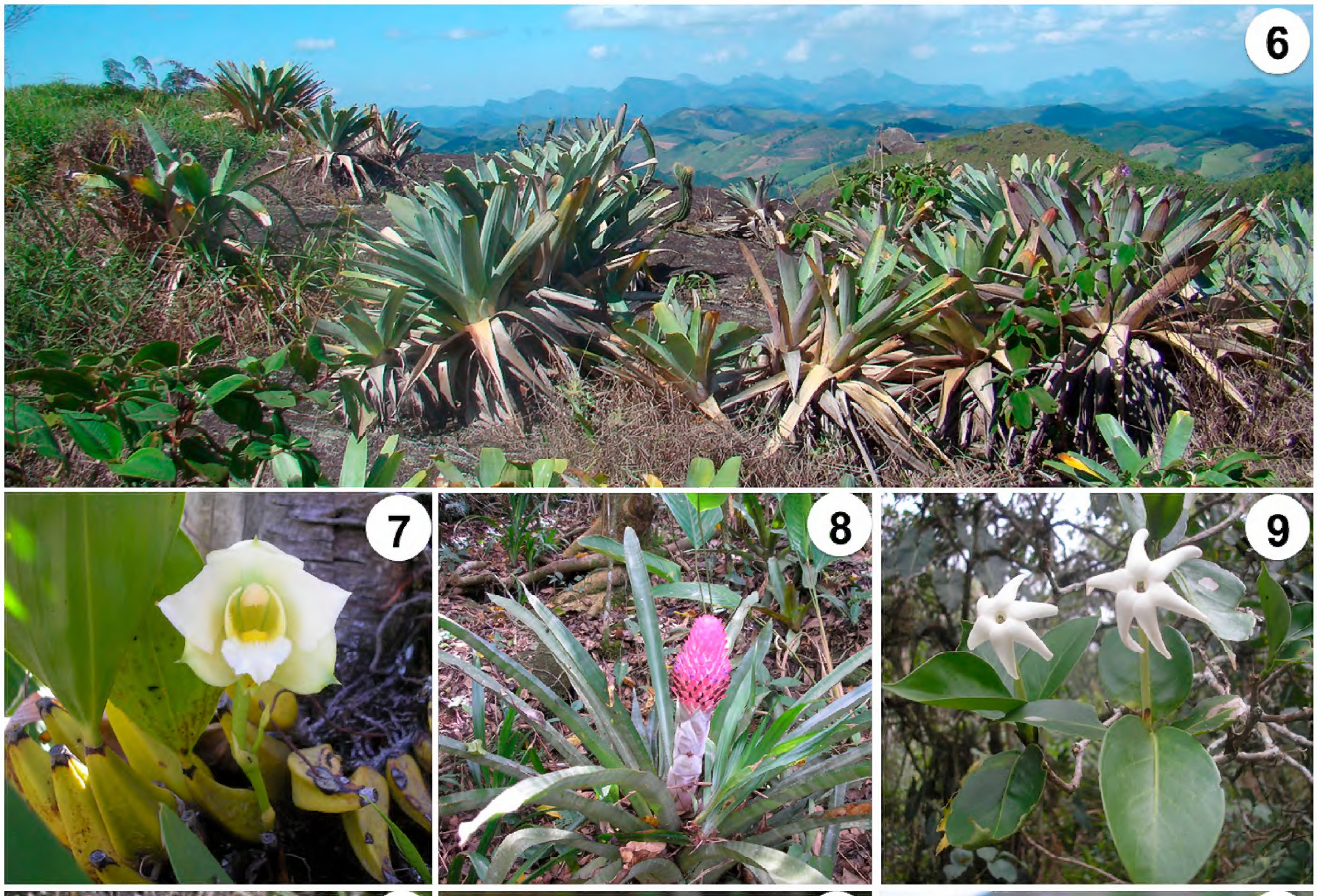


Figure 6–15. Holorupicolous flora species of inselberg in Pedra dos Pontões, Mimoso do Sul, Espírito Santo, Brazil. **6.** Population of *Alcantarea* aff. *patriae*. **7.** *Bifrenaria thyrianthyna*. **8.** *Quesnelia arvensis*. **9.** *Posoqueria* sp.. **10.** *Baccharis platypoda*. **11.** *Utricularia nelumbifolia*. **12.** *Sinningia brasiliensis*. **13.** *Vellozia plicata*. **14.** *Trembleya* cf. *parviflora*. **15.** *Tillandsia geminiflora*. Photos by D.R. Couto.

Table 1. List of vascular plant species recorded on inselberg Pedra dos Pontões, Mimoso do Sul, ES, Brazil. Vegetative habit: Subshrub = Subsh, Shrub = Shrub, Tree = Tree, Climbing plants = Climb., Herbaceous = Herb; Substrate: Epi = epiphyte, Rup = holorupicolous, Hem = hemiepiphyte; Rocky habitat types: Iv = island of herbaceous vegetation, Tw = woody thicket; Voucher collector name and number, and herbarium acronym and number in parenthesis. (*) endemic species; (**) invasive species.

Family / Species	Vegetative habit	Substrate	Rocky habitat types		Voucher	Geographic Coordinates	
			Iv	Tw		Latitude S	Longitude W
Acanthaceae (1)							
Ruellia sp.	Subsh	Rup		x	D.R.Couto 1141 (MBML 39233)	20°56′ 20″	041°32′ 20″
Alstroemeriaceae (1)							
Alstroemeria cunha Vell.	Herb	Rup	x		D.R.Couto 1964 (VIES)	20°56′20″	041°33′19″
Amaryllidaceae (1)							
Hippeastrum aulicum Herb.	Herb	Rup	x		D.R.Couto 1986 (VIES)	20°56′20″	041°33′19″
Anemiaceae (2)							
Anemia sp.1	Herb	Rup	x		D.R.Couto 1943 (VIES 20457)	20°56′20″	041°33′19″
Anemia sp.2	Herb	Rup	x		D.R.Couto 1641 (VIES 20458)	20°56′20″	041°33′19″
Aquifoliaceae (1)							
Ilex sp.	Tree	Rup	x		D.R.Couto 922 (MBML)	-	
Araceae (8)							
Anthurium scandens (Aubl.) Engl.	Herb	Epi		x	D.R.Couto 214 (MBML 38570)	20°56′19″	041°32′36″
Anthurium solitarium Schott	Herb	Rup		x	D.R.Couto 898 (VIES 31706)	20°56′19″	041°32′36″
Anthurium sp. 1	Herb	Rup		x	D.R.Couto 2103 (VIES 30955)	20°56′19″	041°32′36″
Anthurium sp. 2	Herb	Epi		x	D.R.Couto 2105 (VIES 30963)	20°56′19″	041°32′36″
Asterostigma lombardii E.G.Gonç.	Herb	Rup		x	D.R.Couto 2060 (VIES 30954)	20°56′19″	041°32′38″
Philodendron acutatum Schott	Herb	Hem		x	D.R.Couto1347 (VIES 30959)	20°56′08″	041°33′14″
Philodendron cordatum Kunth ex Schott	Herb	Hem		x	D.R.Couto 2070 (VIES 30962)	20°56′19″	041°32′36″
Philodendron edmundoi G.M.Barroso	Herb	Rup	x		D.R.Couto 926 (MBML 39230)	20°56′19″	041°32′38″
Araliaceae (1)							
Oreopanax capitatus (Jacq.) Decne. & Planch.	Tree	Hem		x	D.R.Couto 1941 (VIES 30355)	20°56′19″	041°32′36″
Apocynaceae (2)							
Ditassa mucronata Mart.	Cimb.	Rup	x	x	D.R.Couto 279 (MBML 38763)	20°56′16″	041°33′18″
Oxypetalum sp.	Climb.	Rup	x		D.R.Couto 1105 (MBML 41677)	20°56′19″	041°32′36″
Aspleniaceae (3)							
Asplenium harpeodes Kunze	Herb	Epi		x	D.R.Couto 2120 (VIES)	20°56′19″	041°32′36″
Asplenium praemorsum Sw.	Herb	Epi		x	D.R.Couto 2230 (VIES)	20°56′19″	041°32′38″
Asplenium serra Langsd. & Fisch.	Herb	Epi		x	D.R.Couto 2113 (VIES 30255)	20°56′19″	041°32′36″
Asteraceae (6)							
Baccharis platypoda DC.	Shrub	Rup	x		D.R.Couto 925 (VIES 21739)	20°56′33″	041°32′55″
Baccharis punctulata DC.	Subsh	Rup	x	x	D.R.Couto 1644 (VIES 33768)	20°56′28″	041°32′44″
Cololobus rupestris (Gardner) H. Rob	Subsh	Rup	x	x	D.R.Couto 1937 (VIES)	20°56′19″	041°32′38″
Eremanthus crotonoides (DC.) Sch.Bip.	Tree	Rup	x		D.R.Couto 1375 (VIES 33727)	20°56′19″	041°32′38″
Mikania micrantha Kunth	Climb.	Rup	x		D.R.Couto 1106 (MBML 41678)	20°56′28″	041°32′44″
Vernonanthura polyanthes (Spreng.) A.J. Vega & M. Dematt.	Subsh	Rup		x	D.R.Couto 1645 (VIES 33769)	20°56′19″	041°32′38″
Begoniaceae (4)							
Begonia cucullata Willd.	Herb	Rup	x		D.R.Couto 1096 (MBML 38386)	20°56′19″	041°32′38″
Begonia curtii L.B.Sm. & B.G.Schub.	Herb	Rup	x	x	D.R.Couto 1383 (VIES 33731)	20°56′19″	041°32′36″
Begonia espiritosantensis E.L.Jacques & Mamede	Herb	Rup		x	D.R.Couto 215 (MBML 38497)	20°56′19″	041°32′36″
Begonia reniformis Dryand.	Subsh	Rup	x	x	D.R.Couto 553 (MBML 39145)	20°56′16″	041°33′18″
Bromeliaceae (35)							
Aechmea coelestis (K.Koch) E.Morren	Herb	Epi		x	D.R.Couto 900 (MBML 40172)	20°56′08″	041°33′14″
Aechmea lamarchei Mez	Herb	Rup		x	D.R.Couto 928 (MBML 39160)	20°56′19″	041°32′38″
Aechmea nudicaulis (L.) Griseb.	Herb	Epi		x	V.C. Manhães 18 (MBML 35372)	20°56′28″	041°32′44″
Aechmea ramosa Mart. ex Schult. & Schult.f.	Herb	Epi		x	V.C. Manhães 43 (MBML 35409)	20°56′19″	041°32′36″
Aechmea saxicola L.B.Sm.	Herb	Rup		x	V.C. Manhães 27 (MBML 35363)	20°56′19″	041°32′36″
Aechmea aff. *squarrosa* Baker	Herb	Rup		x	D.R.Couto 1457 (VIES 21320)	20°56′08″	041°33′14″
Alcantarea aff. *patriae* Versieux & Wand.	Herb	Rup	x	x	D.R.Couto. 1792 (VIES 21390)	20°56′28″	041°32′44″
Billbergia aff. *iridifolia* (Nees & Mart.) Lindl.	Herb	Rup		x	D.R.Couto 173 (MBML 38491)	20°56′19″	041°32′38″
Billbergia horrida Regel	Herb	Epi		x	V.C.Manhães 15 (MBML 35404)	20°56′28″	041°32′44″
Billbergia lietzei E.Morren	Herb	Rup		x	D.R.Couto 1450 (VIES 21312)	20°56′19″	041°32′36″
Billbergia tweedieana Baker	Herb	Epi		x	D.R.Couto 2069 (VIES 21309)	20°56′19″	041°32′36″
Billbergia zebrina (Herb.) Lindl.	Herb	Epi		x	D.R.Couto 2111 (VIES 21322)	20°56′19″	041°32′36″
Bromelia antiacantha Bertol.	Herb	Rup		x	D.R.Couto 2067 (VIES 21310)	20°56′08″	041°33′14″
Catopsis sessiliflora (Ruiz & Pav.) Mez	Herb	Epi		x	D.R.Couto 1350 (VIES 21308)	20°56′19″	041°32′36″

Continued

Table 1. *Continued.*

Family / Species	Vegetative habit	Substrate	Rocky habitat types		Voucher	Geographic Coordinates	
			Iv	Tw		Latitude S	Longitude W
Edmundoa lindenii (Regel) Leme	Herb	Epi		x	D.R.Couto 1456 (VIES)	20°56'19"	041°32'38"
**Neoregelia dayvidiana* Leme & A.P.Fontana	Herb	Epi		x	E. Leme 7566 (MBML 39358)	20°56'08"	041°33'14"
Neoregelia pauciflora L.B.Sm.	Herb	Rup		x	V.C.Manhães 41 (MBML 35395)	20°56'19"	041°32'38"
**Pitcairnia abyssicola* Leme & Kollmann	Herb	Rup	x	x	D.R.Couto 281 (MBML 38553)	20°56'16"	041°33'18"
Pitcairnia decidua L.B.Sm.	Herb	Rup	x	x	D.R.Couto 1102 (MBML 39232)	20°56'28"	041°32'44"
Pitcairnia flammea Lindl.	Herb	Rup	x	x	H.M. Dias 630 (VIES 21678)	20°56'19"	041°32'38"
Pitcairnia glaziovii Baker	Herb	Rup	x		D.R.Couto 3244 (R)	20°56'20"	041°33'19"
Quesnelia arvensis (Vell.) Mez	Herb	Rup		x	V.C.Manhães 16 (MBML 35388)	20°56'19"	041°32'36"
Quesnelia kautskyi C.M.Vieira	Herb	Rup		x	V.C.Manhães 11 (MBML 35391)	20°56'19"	041°32'38"
Quesnelia strobilispica Wawra	Herb	Rup		x	D.R.Couto 1615 (VIES 21328)	20°56'19"	041°32'36"
Tillandsia gardneri Lindl.	Herb	Epi		x	D.R.Couto 1245 (VIES 21326)	20°56'19"	041°32'38"
Tillandsia geminiflora Brongn.	Herb	Epi	x		D.R.Couto 178 (MBML 38511)	20°56'26"	041°32'46"
Tillandsia recurvata (L.) L.	Herb	Epi		x	D.R.Couto 294 (MBML 38516)	20°56'19"	041°32'38"
Tillandsia stricta Sol.	Herb	Epi		x	V.C. Manhães 4 (MBML 35390)	20°56'16"	041°33'18"
Tillandsia tenuifolia L.	Herb	Epi		x	V.C. Manhães 2 (MBML 35367)	20°56'19"	041°32'38"
Tillandsia usneoides (L.) L.	Herb	Epi		x	V.C. Manhães 12 (MBML 35392)	20°56'19"	041°32'36"
Vriesea cf. *flava* A.F.Costa et al.	Herb	Epi		x	D.R.Couto 901 (VIES 21158)	20°56'08"	041°33'14"
Vriesea fosteriana L.B.Sm.	Herb	Rup	x		D.R.Couto 2016 (VIES 21324)	20°56'20"	041°33'19"
Vriesea gigantea Gaudich.	Herb	Epi		x	D.R.Couto 2128 (VIES 21321)	20°56'19"	041°32'36"
Vriesea lubbersii (Baker) E.Morren	Herb	Epi		x	D.R.Couto 1939 (VIES 21323)	20°56'19"	041°32'38"
Vriesea pseudoatra Leme	Herb	Rup	x		D.R.Couto 940 (MBML 39191)	20°56'25,5"	041°33'19"
Cactaceae (8)							
Coleocephalocereus fluminensis (Miq.) Backeb.	Herb	Rup	x		D.R.Couto 913 (VIES 21740)	20°56'26"	041°32'46"
Hatiora cylindrica Britton & Rose	Herb	Rup	x	x	D.R.Couto 904 (VIES 21142)	20°56'16"	041°33'18"
Hatiora salicornioides (Haw.) Britton & Rose	Herb	Rup		x	D.R.Couto 1343 (VIES 30231)	20°56'19"	041°32'36"
Lepismium houlletianum (Lem.) Barthlott	Herb	Epi		x	D.R.Couto 1238 (VIES 30230)	20°56'19"	041°32'38"
Rhipsalis crispata (Haw.) Pfeiff.	Herb	Epi		x	D.R.Couto 1952 (UFRN 15689)	20°56'19"	041°32'36"
Rhipsalis lindbergiana K.Schum.	Herb	Epi		x	D.R.Couto 292 (MBML 38567)	20°56'19"	041°32'36"
Rhipsalis neves-armondii K. Schum	Herb	Epi		x	D.R.Couto 1116 (MBML 41668)	20°56'19"	041°32'38"
Rhipsalis teres (Vell.) Steudt.	Herb	Epi		x	D.R.Couto 328 (MBML 39595)	20°56'19"	041°32'36"
Campanulaceae (1)							
Lobelia thapsoidea Schott	Herb	Rup	x		D.R.Couto 1635 (VIES 33764)	20°56'26"	041°32'46"
Cannaceae(1)							
Canna indica L.	Herb	Rup	x		D.R.Couto 545 (MBML 39110)	20°56'26"	041°32'46"
Clusiaceae (3)							
Clusia aemygdioi Gomes da Silva & B.Weinberg	Tree	Rup		x	D.R.Couto 2073 (VIES 33790)	20°56'19"	041°32'36"
Clusia criuva Cambess.	Tree	Rup		x	D.R.Couto 1246 (VIES 33703)	20°56'26"	041°32'46"
Clusia organensis Planch. & Triana	Tree	Rup		x	D.R.Couto 1247 (VIES 33704)	20°56'19"	041°32'36"
Commelinaceae (1)							
Gibasis geniculata (Jacq.) Rohweder	Herb	Rup		x	D.R.Couto 1143 (MBML 39618)	20°56'19"	041°32'36"
Costaceae (1)							
Costus spiralis (Jacq.) Roscoe	Herb	Rup		x	D.R.Couto 1384 (VIES 33732)	20°56'28"	041°32'44"
Cyperaceae (2)							
Scleria sp.	Herb	Rup	x		D.R.Couto 918 (VIES 21124)	20°56'28"	041°32'44"
Trilepis lhotzkiana Nees ex Arn.	Herb	Rup	x		D.R.Couto 302 (MBML 38770)	20°56'26"	041°32'46"
Dioscoreaceae (1)							
Dioscorea sp.	Herb	Rup		x	D.R.Couto 1561 (VIES 33753)	20°56'16"	041°33'18"
Dryopteridaceae (1)							
Rumohra adiantiformis (G.Forst.) Ching	Herb	Rup	x		D.R.Couto 924 (MBML 40829)	20°56'20"	041°33'19"
Euphorbiaceae (2)							
Acalypha communis Müll.Arg.	Subsh	Rup		x	D.R.Couto 1332 (VIES 33709)	20°56'19"	041°32'38"
Manihot sp.	Subsh	Rup		x	D.R.Couto 1329 (VIES 33708)	20°56'19"	041°32'36"
Gesneriaceae (6)							
Codonanthe devosiana Lem.	Herb	Epi		x	D.R.Couto 899 (VIES 21112)	20°56'08"	041°33'14"
Nematanthus lanceolatus (Poir.) Chautems	Herb	Epi		x	D.R.Couto 1334 (VIES 21525)	20°56'19"	041°32'36"
Paliavana prasinata (Ker Gawl.) Benth.	Subsh	Rup	x	x	D.R.Couto 1609 (VIES 33763)	20°56'19"	041°32'38"
Sinningia brasiliensis (Regel & Schmidt) Wiehler & Chautems	Herb	Rup	x		D.R.Couto 1578 (VIES)	20°56'33"	041°32'55"
Sinningia magnifica (Otto & A.Dietr.) Wiehler	Herb	Rup	x		D.R.Couto 1984 (VIES)	20°56'25,5"	041°33'19"
Vanhouttea calcarata Lem.	Subsh	Rup	x		D.R.Couto 157 (MBML 38509)	20°56'20"	041°33'19"

Continued

Table 1. *Continued.*

Family / Species	Vegetative habit	Substrate	Rocky habitat types		Voucher	Geographic Coordinates	
			Iv	Tw		Latitude S	Longitude W
Fabaceae (1)							
Collaea sp.	Shrub	Rup	x		D.R.Couto 1099 (MBML 41674)	20°56′26″	041°32′46″
Lentibulariaceae (2)							
Utricularia sp.	Herb	Rup	x		D.R.Couto 1788 (VIES 33780)	20°56′26″	041°32′46″
Utricularia nelumbifolia Gardner	Herb	Epi	x		D.R.Couto 547 (MBML 39155)	20°56′26″	041°32′47″
Lythraceae (1)							
Cuphea carthagenensis (Jacq.) J.Macbr.	Subsh	Rup	x		D.R.Couto 1575 (VIES 33757)	20°56′26″	041°32′45″
Loasaceae (1)							
Aosa sp.	Herb	Rup	x	x	D.R.Couto 1340 (VIES 33713)	20°56′33″	041°32′55″
Lomariopsidaceae (1)							
Nephrolepis exaltata (L.) Schott	Herb	Rup		x	D.R.Couto 1348 (VIES 20410)	20°56′19″	041°32′38″
Malpighiaceae (1)							
Heteropterys rufula A.Juss.	Climb.	Rup		x	D.R.Couto 261 (SP 446536)	20°56′19″	041°32′36″
Malvaceae (1)							
Pseudobombax sp.nov.	Tree	Rup	x	x	D.R.Couto 1610 (VIES 20094)	20°56′19″	041°32′36″
Marantaceae (2)							
Calathea sp.	Herb	Rup		x	D.R.Couto 1551 (VIES 33750)	20°56′21″	041°32′37″
Ctenanthe sp.	Herb	Rup		x	D.R.Couto 1379 (VIES 33729)	20°56′ 32″	041°32′ 34″
Marcgraviaceae (1)							
Schwartzia cf. *brasiliensis* (Choisy) Bedell ex Gir.-Cañas	Climb.	Rup		x	L.Kollmann 6813 (MBML 22626)	20°56′21″	041°32′37″
Melastomataceae (5)							
Leandra aurea (Cham.) Cogn.	Subsh	Rup		x	D.R.Couto 1636 (VIES 33765)	20°56′	041°32′
Miconia polyandra Gardner.	Subsh	Rup	x		D.R.Couto 1785 (VIES 33777)	20°56′	041°32′
Tibouchina castellensis Brade	Shrub	Rup	x		D.R.Couto 258 (MBML 38762)	20°56′26″	041°32′46″
Tibouchina heteromalla (D.Don) Cogn.	Shrub	Rup	x	x	D.R.Couto 1582 (VIES 33761)	20°56′28″	041°32′44″
Trembleya cf. *parviflora* (D.Don) Cogn.	Subsh	Rup	x		D.R.Couto 765 (MBML 49368)	20°56′26″	041°32′46″
Moraceae (1)							
Ficus arpazusa Casar.	Shrub	Hem		x	D.R.Couto 1406 (VIES 33738)	20°56′21″	041°32′37″
Myrtaceae (4)							
Eugenia candolleana DC.	Shrub	Rup	x		D.R.Couto 1092 (MBML 38390)	20°56′21″	041°32′37″
Myrcia hartwegiana (O.Berg) Kiaersk.	Shrub	Rup	x		D.R.Couto 931 (MBML 39157)	20°56′08″	041°33′14″
Myrcia cf. *splendens* (Sw.) DC.	Shrub	Rup	x	x	L.Kollmann 11173 (MBML 36093)	20°56′08″	041°33′14″
Myrciaria glazioviana (Kiaersk.) G.M.Barroso ex Sobral	Shrub	Rup		x	L.Kollmann 6835 (MBML 22612)	20°56′21″	041°32′37″
Nyctaginaceae (1)							
Guapira opposita (Vell.) Reitz	Tree	Rup		x	D.R.Couto 911 (MBML 40826)	20°56′08″	041°33′14″
Orchidaceae (59)							
Acianthera auriculata (Lindl.) Pridgeon & M.W.Chase	Herb	Epi		x	D.R.Couto 1 (MBML 38429)	20°56′20″	041°32′38″
Acianthera crinita (Barb.Rodr.) Pridgeon & M.W.Chase	Herb	Epi		x	D.R.Couto 91 (MBML 38409)	20°56′20″	041°32′36″
Acianthera heliconiscapa (Hoehne) F.Barros	Herb	Epi		x	D.R.Couto 324 (MBML 43916)	20°56′20″	041°32′38″
Acianthera leptotifolia (Barb.Rodr.) Pridgeon & M.W.Chase	Herb	Epi		x	D.R.Couto 145 (MBML 38411)	20°56′19″	041°32′36″
Acianthera prolifera (Herb. ex Lindl.) Pridgeon & M.W.Chase	Herb	Rup	x		D.R.Couto 96 (MBML 38483)	20°56′20″	041°33′19″
Acianthera saurocephala (Lodd.) Pridgeon & M.W.Chase	Herb	Epi		x	D.R.Couto 172 (MBML 38816)	20°56′19″	041°32′36″
Alatiglossum longipes (Lindl.) Baptista	Herb	Rup	x	x	D.R.Couto 219 (MBML 38442)	20°56′08″	041°33′14″
Aspasia lunata Lindl.	Herb	Epi		x	D.R.Couto 191 (MBML 38529)	20°56′19″	041°32′36″
Barbosella spiritusanctensis (Pabst) F.Barros & Toscano	Herb	Epi		x	D.R.Couto 618 (MBML 38093)	20°56′20″	041°32′38″
Bifrenaria tyrianthina (Lodd.) Rchb.f.	Herb	Rup	x		D.R.Couto 83 (MBML 38524)	20°56′20″	041°33′19″
Brasiliorchis marginata (Lindl.) R.B.Singer et al.	Herb	Epi	x	x	D.R.Couto 218 (MBML 38454)	20°56′33″	041°32′55″
Brasiliorchis phoenicanthera (Barb.Rodr.) R.B.Singer et al.	Herb	Epi		x	D.R.Couto 125 (MBML 38465)	20°56′19″	041°32′36″
Brasiliorchis picta (Hook.) R.B.Singer et al.	Herb	Rup	x		D.R.Couto 332 (MBML 39645)	20°56′19″	041°32′36″
Bulbophyllum cantagallense (Barb.Rodr.) Cogn.	Herb	Epi		x	D.R.Couto 14 (MBML 38804)	20°56′20″	041°32′38″
Campylocentrum ornithorrhynchum (Lindl.) Rolfe	Herb	Epi		x	D.R.Couto 128 (MBML 38774)	20°56′08″	041°33′14″
Cattleya coccinea Lindl.	Herb	Rup	x		D.R.Couto 58 (MBML 38476)	20°56′25″	041°33′19″
Christensonella pachyphylla (Schltr. ex Hoehne) Szlach. et al.	Herb	Epi		x	D.R.Couto 23 (MBML 38478)	20°56′20″	041°32′38″

Continued

Table 1. *Continued.*

Family / Species	Vegetative habit	Substrate	Rocky habitat types		Voucher	Geographic Coordinates	
			Iv	Tw		Latitude S	Longitude W
Christensonella pumila (Hook.) Szlach. et al.	Herb	Rup	x		D.R.Couto 185 (MBML 38505)	20°56′33″	041°32′55″
Christensonella subulata (Lindl.) Szlach. et al.	Herb	Epi		x	D.R.Couto 122 (MBML 38453)	20°56′20″	041°32′38″
Coppensia majevskyi (Toscano & V.P.Castro) Campacci	Herb	Rup	x		D.R.Couto 271 (MBML 38542)	20°56′25.5″	041°33′19″
Cyrtopodium glutiniferum Raddi	Herb	Rup	x	x	D.R.Couto 190 (MBML 38791)	20°56′16″	041°33′18″
Elleanthus brasiliensis (Lindl.) Rchb.f.	Herb	Rup	x	x	D.R.Couto 244 (MBML 38416)	20°56′20″	041°32′38″
Encyclia patens Hook.	Herb	Epi		x	D.R.Couto 124 (MBML 38790)	20°56′20″	041°32′38″
Epidendrum avicula Lindl.	Herb	Epi		x	D.R.Couto 123 (MBML 38796)	20°56′19″	041°32′36″
Epidendrum campaccii Hágsater & L.Sánchez	Herb	Epi		x	D.R.Couto 2 (MBML 38464)	20°56′19″	041°32′36″
Epidendrum densiflorum Lindl.	Herb	Rup	x	x	D.R.Couto 380 (MBML 38817)	20°56′16″	041°33′18″
Epidendrum rigidum Jacq.	Herb	Epi		x	D.R.Couto 126 (MBML 38506)	20°56′19″	041°32′36″
Epidendrum secundum Jacq.	Herb	Rup	x		H.M.Dias 623 (VIES 21682)	20°56′16″	041°33′18″
Epidendrum tridactylum Lindl.	Herb	Epi		x	D.R.Couto 90 (MBML 38481)	20°56′19″	041°32′36″
Eurystyles actinosophila (Barb.Rodr.) Schltr.	Herb	Epi		x	D.R.Couto 105 (MBML 38815)	20°56′21″	041°32′37″
Gomesa recurva R.Br.	Herb	Epi		x	D.R.Couto 127 (MBML 38468)	20°56′21″	041°32′37″
Grandiphyllum divaricatum (Lindl.) Docha Neto	Herb	Epi		x	D.R.Couto 24 (MBML 38823)	20°56′21″	041°32′37″
Habenaria parviflora Lindl.	Herb	Rup	x		D.R.Couto 1090 (MBML 38391)	20°56′26″	041°32′46″
Heterotaxis brasiliensis (Brieger and Illg) F.Barros	Herb	Epi		x	D.R.Couto 76 (MBML 38417)	20°56′28″	041°32′44″
Hoffmannseggella cinnabarina (Batem. ex Lindl.) H.G.Jones	Herb	Rup	x		D.R.Couto 184 (MBML 38427)	20°56′25.5″	041°33′19″
Isochilus linearis (Jacq.) R.Br.	Herb	Epi	x	x	D.R.Couto 64 (MBML 38477)	20°56′26″	041°32′46″
Maxillariella robusta (Barb.Rodr.) M.A.Blanco & Carnevali	Herb	Epi		x	D.R.Couto 320 (MBML 39647)	20°56′19″	041°32′36″
Mesadenella cuspidata (Lindl.) Garay	Herb	Rup		x	D.R.Couto 146 (MBML 38450)	20°56′20″	041°32′38″
Mormolyca rufescens (Lindl.) M.A.Blanco	Herb	Epi		x	D.R.Couto 59 (MBML 38793)	20°56′19″	041°32′36″
Octomeria chamaeleptotes Rchb.f.	Herb	Epi		x	D.R.Couto 18 (MBML 38800)	20°56′20″	041°32′38″
Octomeria crassifolia Lindl.	Herb	Epi	x	x	D.R.Couto 152 (MBML 38541)	20°56′20″	041°32′38″
Octomeria decumbens Cogn.	Herb	Epi		x	D.R.Couto 325 (MBML 38802)	20°56′20″	041°32′38″
Octomeria tricolor Rchb.f.	Herb	Rup	x		D.R.Couto 74 (MBML 38819)	20°56′08″	041°33′14″
Oeceoclades maculata (Lindl.) Lindl.	Herb	Rup		x	D.R.Couto 67 (MBML 38455)	20°56′20″	041°32′38″
Ornithidium rigidum (Barb.Rodr.) M.A.Blanco & Ojeda	Herb	Epi		x	D.R.Couto 234 (MBML 38503)	20°56′20″	041°32′38″
Polystachya concreta (Jacq.) Garay & Sweet	Herb	Epi		x	D.R.Couto 249 (MBML 38418)	20°56′28″	041°32′44″
Prescottia plantaginifolia Lindl. ex Hook.	Herb	Rup	x	x	D.R.Couto 140 (MBML 38474)	20°56′16″	041°33′18″
Prescottia sp. 1	Herb	Rup	x		D.R.Couto 142 (MBML 38812)	20°56′25.5″	041°33′19″
Prescottia sp. 2	Herb	Rup	x		D.R.Couto 546 (MBML 39131)	20°56′26″	041°32′46″
Rhetinantha notylioglossa (Rchb.f.) M.A.Blanco	Herb	Epi	x		D.R.Couto 73 (MBML 38539)	20°56′20″	041°32′38″
Sacoila lanceolata (Aubl.) Garay	Herb	Rup	x		D.R.Couto 921 (VIES 21070)	20°56′16″	041°33′18″
Sauroglossum elatum Lindl.	Herb	Rup		x	D.R.Couto 171 (MBML 38776)	20°56′16″	041°33′18″
Scaphyglottis modesta (Rchb.f.) Schltr.	Herb	Rup	x		D.R.Couto 71 (MBML 38463)	20°56′26″	041°32′46″
Specklinia grobyi (Batem. ex Lindl.) F.Barros	Herb	Epi		x	D.R.Couto 28 (MBML 38459)	20°56′08″	041°33′14″
Stelis argentata Lindl.	Herb	Epi		x	D.R.Couto 225 (MBML 38530)	20°56′21″	041°32′37″
Stelis deregularis Barb.Rodr.	Herb	Rup		x	D.R.Couto 87 (MBML 38471)	20°56′20″	041°32′38″
Xylobium variegatum (Ruiz & Pav.) Mansf.	Herb	Rup		x	D.R.Couto 189 (MBML 38527)	20°56′20″	041°32′38″
Zygopetalum intermedium Lodd.	Herb	Rup	x	x	D.R.Couto 254 (MBML 38833)	20°56′19″	041°32′36″
Zygopetalum maculatum (Kunth) Garay	Herb	Rup	x		D.R.Couto 98 (MBML 38457)	20°56′26″	041°32′46″
Orobanchaceae (1)							
Esterhazya splendida J.C.Mikan	Subsh	Rup	x		D.R.Couto 1577 (VIES 33759)	20°56′26″	041°32′46″
Phyllanthaceae (1)							
Phyllanthus subemarginatus Müll.Arg.	Subsh	Rup		x	D.R.Couto 1341 (VIES 33714)	20°56′26″	041°32′46″
Piperaceae (7)							
Peperomia blanda (Jacq.) Kunth	Herb	Rup		x	D.R.Couto 1142 (MBML 39617)	20°56′20″	041°32′38″
*Peperomia galioides*Kunth	Herb	Rup	x		D.R.Couto 923 (VIES 21080)	20°56′20″	041°33′19″
Peperomia itatiaiana Yunck.	Herb	Rup		x	D.R.Couto 2102 (VIES 30980)	20°56′19″	041°32′36″
Peperomia rotundifolia (L.) Kunth	Herb	Epi		x	D.R.Couto 1372 (VIES 30984)	20°56′20″	041°32′38″
Peperomia rubricaulis (Nees) A.Dietr.	Herb	Epi		x	D.R.Couto 1380 (VIES 30978)	20°56′19″	041°32′36″
Peperomia tetraphylla (G.Forst.) Hook. & Arn.	Herb	Epi		x	D.R.Couto 2066 (VIES 30983)	20°56′21″	041°32′37″
Peperomia trinervis Ruiz & Pav.	Herb	Rup		x	D.R.Couto 1237 (VIES 30979)	20°56′08″	041°33′14″
Poaceae (1)							
***Melinis minutiflora* P.Beauv.	Herb	Rup	x	x	D.R.Couto 2231 (VIES)	20°56′21″	041°32′37″

Continued

Table 1. *Continued.*

Family / Species	Vegetative habit	Substrate	Rocky habitat types		Voucher	Geographic Coordinates	
			Iv	Tw		Latitude S	Longitude W
Polypodiaceae (13)							
Campyloneurum acrocarpon Fée	Herb	Rup	x	x	D.R.Couto 1331 (VIC 37573)	20°56′20″	041°32′38″
Campyloneurum centrobrasilianum Lellinger	Herb	Epi		x	D.R.Couto 2254 (VIES)	20°56′20″	041°32′38″
Microgramma percussa (Cav.) de la Sota	Herb	Epi		x	D.R.Couto 1445 (VIC 37576)	20°56′21″	041°32′37″
Microgramma squamulosa (Kaulf.) de la Sota	Herb	Epi	x	x	D.R.Couto 1408 (VIES 20441)	20°56′19″	041°32′36″
Microgramma tecta (Kaulf.) Alston	Herb	Epi		x	D.R.Couto 2116 (VIC 30257)	20°56′20″	041°32′38″
Niphidium crassifolium (L.) Lellinger	Herb	Epi		x	D.R.Couto 1447 (VIES 20295)	20°56′20″	041°32′38″
Pecluma plumula (Willd.) M.G.Price	Herb	Rup		x	D.R.Couto 1443 (VIC 20320)	20°56′19″	041°32′36″
Pecluma pectinatiformis (Lindm.) M.G.Price	Herb	Epi		x	D.R.Couto 2118 (VIES)	20°56′21″	041°32′37″
Pleopeltis astrolepis (Liebm.) E.Fourn.	Herb	Epi		x	D.R.Couto 2108 (VIC 30254)	20°56′21″	041°32′37″
Pleopeltis hirsutissima (Raddi) de la Sota	Herb	Epi		x	D.R.Couto 1448 (VIES 20285)	20°56′28″	041°32′44″
Pleopeltis minima (Bory) J. Prado & R.Y. Hirai	Herb	Epi		x	D.R.Couto 2127 (VIES)	20°56′20″	041°32′38″
Pleopeltis pleopeltifolia (Raddi) Alston	Herb	Epi		x	D.R.Couto 1954 (VIES 30263)	20°56′28″	041°32′44″
Serpocaulon latipes (Langsd. & Fisch.) A.R.Sm.	Herb	Rup		x	D.R.Couto 1108 (MBML 38400)	20°56′16″	041°33′18″
Portulacaceae (1)							
Portulaca hirsutissima Cambess.	Herb	Rup	x	x	D.R.Couto 1639 (VIES 33766)	20°56′16″	041°33′18″
Primulaceae (1)							
Myrsine venosa A.DC.	Tree	Rup	x	x	D.R.Couto 916 (MBML 27369)	20°56′28″	041°32′44″
Pteridaceae (2)							
Doryopteris collina (Raddi) J. Sm.	Herb	Rup	x	x	D.R.Couto 1955 (VIES)	20°56′20″	041°32′38″
Doryopteris sp.	Herb	Rup	x	x	D.R.Couto 1558 (VIES)	20°56′16″	041°33′18″
Rubiaceae (3)							
Borreria sp.	Subsh	Rup		x	D.R.Couto 1381 (VIES 33730)	20°56′20″	041°32′38″
**Bradea* sp. nov.	Subsh	Rup		x	D.R.Couto 1144 (MBML 39619)	20°56′21″	041°32′37″
Posoqueria sp.	Climb.	Rup		x	D.R.Couto 551 (MBML 39172)	20°56′21″	041°32′37″
Smilacaceae (1)							
Smilax sp.	Climb.	Rup	x		D.R.Couto 1786 (VIES 33778)	20°56′16″	041°33′18″
Solanaceae (2)							
Markea atlantica Stehmann & Giacomin	Climb.	Hem		x	D.R.Couto 1455 (VIES 30354)	20°56′20″	041°32′38″
Solanum swartzianum Roem. & Schult.	Shrub	Rup	x		D.R.Couto 277 (MBML 38768)	20°56′08″	041°33′14″
Velloziaceae (3)							
Barbacenia sp.	Herb	Rup	x		D.R.Couto 250 (MBML 38554)	20°56′26″	041°32′46″
Vellozia plicata Mart.	Shrub	Rup	x		D.R.Couto 299 (MBML 38760)	20°56′26″	041°32′46″
Vellozia variegata Goethart & Henrard	Shrub	Rup	x		D.R.Couto 298 (MBML 38773)	20°56′28″	041°32′44″
Verbenaceae (1)							
Stachytarpheta sp.	Subsh	Rup	x		D.R.Couto 1580 (VIES 33760)	20°56′28″	041°32′44″
Xyridaceae (1)							
Xyris sp.	Herb	Rup		x	D.R.Couto 1392 (VIES 33735)	20°56′33″	041°32′55″

represented by only a single species, and 33% by less than six species. Of these, the importance of Bromeliaceae, Velloziaceae, and Orchidaceae on the physiognomy of the area is worth mentioning, as holorupicolous species of these families establish dense single-species groupings on the inselberg (Figures 3 and 4).

The six richest families in this study (Orchidaceae, Bromeliaceae, Polypodiaceae, Araceae, Cactaceae and Piperaceae) represent 61.6% of the total number of species surveyed. The most speciose genera in this study were *Peperomia* (Piperaceae) with seven species, followed by *Aechmea, Tillandsia* (Bromeliaceae), *Acianthera* and *Epidendrum* (Orchidaceae) with six species each and *Billbergia* and *Vriesea* (Bromeliaceae) with five species each.

As for the distribution of species according to vegetative habit (Figure 16), there was a predominance of herbaceous species, with 164 species (78%), followed by subshrubs with 18 species (8%), shrubs with 12 species (5.6%), climbing plants and trees with eight species each (4% each). The occurrence of species according to their preferred substrate showed a higher prevalence of holorupicolous species with 129 species (61%), followed by epiphytes with 77 species (36%) and hemiepiphytes with five species (2%).

As for the rocky habitat types, greater richness was observed in woody thickets, with 122 exclusive species (58%) compared with the islands of herbaceous shrub vegetation, represented by 58 unique species. Of the total, 31 species occur in both habitats types.

In total, 27 species (13%) are included on official lists of endangered species (Table 2), two are endemic species of the study area (*Neoregelia dayvidiana* Leme & A.P.Fontana and *Pitcairnia abyssicola* Leme & Kollmann) and *Ditassa mucronata* Mart. and *Acalypha communis* Müll.Arg., are new records for the flora of ES.

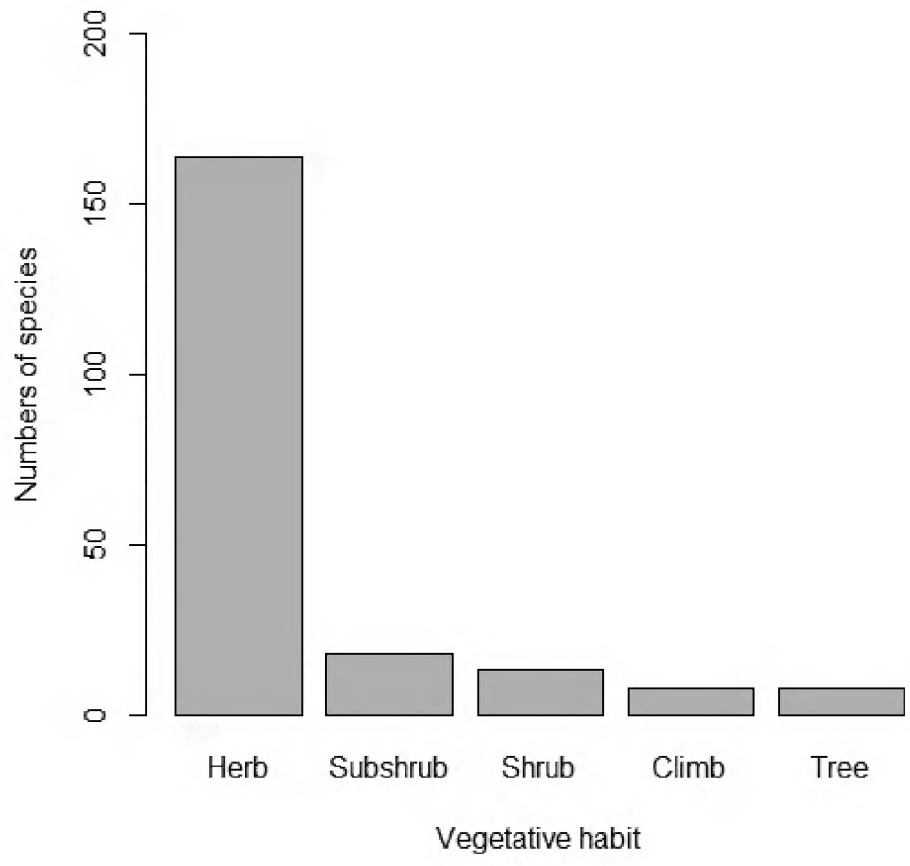


Figure 16. Distribution of species according to vegetative habit registered for inselberg Pedra dos Pontões, Mimoso do Sul, Espírito Santo, Brazil. Herb = herbaceous; Climb. = climbing plants

Table 2. Endangered species registered for the *inselberg* Pedra dos Pontões, Mimoso do Sul, ES, Brazil. Classification based in SIMONELLI & FRAGA (2007) for Espírito Santo state, and MMA (2014) for Brazil. Categories: VU: vulnerable; EN: endangered; CR: critically endangered.

		Categories	
Family	**Species**	**List ES**	**List Brazil**
Araceae	*Asterostigma lombardii*	VU	
Araliaceae	*Oreopanax capitatus*	VU	
Asteraceae	*Cololobus rupestris*	VU	EN
Asteraceae	*Eremanthus crotonoides*	VU	
Begoniaceae	*Begonia curtii*	EN	VU
	Begonia espiritosantensis	CR	EN
Bromeliaceae	*Billbergia lietzei*	VU	
	Pitcairnia decidua	VU	EN
	Pitcairnia glaziovii		EN
	Quesnelia kautskyi	VU	VU
	Vriesea fosteriana	EN	
Clusiaceae	*Clusia aemygdioi*	VU	EN
Gesneriaceae	*Codonanthe devosiana*	EN	
	Nematanthus lanceolatus	EN	
	Sinningia magnifica	VU	
	Vanhouttea calcarata	VU	
Melastomataceae	*Tibouchina castellensis*	CR	CR
Orchidaceae	*Acianthera auriculata*	VU	
	Acianthera saurocephala	EN	
	Barbosella spiritusanctensis	CR	
	Bifrenaria tyrianthina	EN	
	Bulbophyllum cantagallense	CR	
	Cattleya coccinea	EN	
	Coppensia majevskyi	VU	EN
	Grandiphyllum divaricatum		VU
	Maxillariella robusta	VU	
	Octomeria chamaeleptotes		VU

DISCUSSION

Our study provides important contributions to the knowledge of the vascular flora of Pedra dos Pontões inselberg in Mimoso do Sul municipality and reinforces its importance as a priority area for conservation in the state of Espirito Santo.

Relevance of Orchidaceae, Bromeliaceae, Polypodiaceae, Cactaceae and Piperaceae families for species richness of the studied inselberg is mainly due to the important contribution of epiphytism in these families (ZOTZ 2013) that are mainly present in woody thickets. Of the most important families, only Bromeliaceae and Cactaceae are recognized as typical components of South American inselbergs, along with other smaller families represented in this study like Velloziaceae, Commelinaceae, Lentibulariaceae and Xyridaceae (POREMBSKI 2007).

Presence of Orchidaceae as the richest family in this study is similar to observed for Serra do Brigadeiro, Minas Gerais state, in the high-montane inselbergs (*campos de altitude*) by CAIAFA & SILVA (2005). ESGARIO et al. (2009) also found a great richness of Orchidaceae for montane inselbergs in the midwest of ES. Orchidaceae family represents one of the principal floristic elements of inselbergs of northeastern Brazil, with high levels of endemism (POREMBSKI et al.1998; FRANÇA et al. 2006; GOMES & ALVES 2010; PESSOA & ALVES 2014). In both areas, the montane or cloud inselbergs, a favorable environmental factor, such as presence of continuous or intermittent clouds, responsible for horizontal precipitation, seems to be the main reason for this richness, as observed for other groups of xeric environments such as vascular epiphytes (NIEDER et al. 2001).

Although they represent only a few species, typical genera of South American inselbergs were recorded in this study, like *Alcantarea* and *Pitcairnia* (Bromeliaceae), *Coleocephalocereus* (Cactaceae), *Sinningia* (Gesneriaceae) and *Vellozia* (Velloziaceae) (POREMBSKI 2007), as shown in Table 1. The low representation of ferns found in the area follows a pattern of floral richness common to inselbergs world-wide (POREMBSKI 2007).

The importance of herbs, especially monocots, to the floral composition of inselbergs is observed in other studies (OLIVEIRA & GODOY 2007; GOMES & SOBRAL-LEITE 2013). In this study, monocots were responsible for harboring 56% of species and 27% of families recorded for the area, indicating the importance of this group for the vegetation of inselberg, though very often neglected in restoration of areas mined for ornamental stones.

The high number of epiphytic species observed in the study area, though not common for inselbergs, is in agreement with BARTHLOTT & POREMBSKI (2000) observations for the tropics, where there is a strong affinity between epiphytic flora and the flora of rocky outcrops, with similar ecophysiological adaptations observed between rupicolous and epiphytic floras (e.g., stem and leaf succulence, velamen covering of aerial roots in some families, CAM metabolic pathways (crassulacean acid metabolism), presence of water and nutrient retention cisterns, thick cuticles, stomata specialized to prevent water loss, among others), mainly to cope with the xeric environment which

is very similar between the canopy and the rocky outcrops. Another important reason for epiphytes high number is presence of *Pseudobombax* sp. nov. tree. This phorophyte is an inselberg specialist and has been described as a nucleus of biodiversity on inselbergs in the southern portion of Espírito Santo (Couto et al. 2016). Together, this species and *Guapira opposita* (Vell.) Reitz (Nyctaginaceae) support a high richness of vascular epiphytes in the study area.

Extremely important is the presence of 27 endangered species, which 24 species are cited on the list of endangered flora of Espírito Santo (Simonelli & Fraga 2007) and 11 species are recognized by the Red List of Flora of Brazil (MMA 2014).

However, occurrence of Molasses Grass (*Melinis minutiflora* P. Beauv.), an invasive exotic species, has been documented in the area, with an alarming level of colonization in different sectors and environments, where competition with native species is severe, even with large species such as *Alcantarea* aff. *patriae*. The biological invasion process has been responsible for significant changes in the structure and composition of vegetation in diverse ecosystems around the world (D'Antonio & Vitousek 1992; McNeely et al. 2001). In particular, the African grass *Melinis minutiflora* is an extremely aggressive invasive, competing successfully with native flora, being found in many Brazilian protected areas, where it can disfigure the original phytophysiognomy in a few years (Martins et al. 2007, 2011). In addition, worth mentioning the large accumulation of biomass fuel, which aggravates vulnerability to fire, because it alters characteristics of the fire regime of invaded areas (D'Antonio & Vitousek 1992).The high number of endangered species occurring in the studied inselberg and presence of invasive species reinforces the need for conservation initiatives in the area. Endangered species are recognized as key priority indicators for the creation of protected areas worldwide (Brooks et al. 2006), being the most effective way to protect biodiversity (Mittermeier & Scarano 2013).

During field expeditions, two new species were recorded for the area: *Pseudobombax* sp. nov. (Malvaceae, Bombacoideae), which is being described by J.G. Carvalho-Sobrinho and D.R. Couto, and *Bradea* sp. nov. (Rubiaceae) which is being described by J.A.Oliveira.

Because of high diversity and endemism resulting from ecological peculiarities, disjunct distribution of matrix and low utility of these areas for agriculture, inselbergs are excellent sources of ecological, evolutionary, biogeographical and, in particular, comparative studies of floristic diversity. These ecosystems are important refuges for highly specialized flora, and these studies are of high scientific relevance for the proposal of measures and actions to conserve and restore these environments, keeping in mind that Espírito Santo is one of the largest exploiters of ornamental rocks in the world (Sardou Filho et al. 2013). Although located on privately owned lands, future actions should ensure the preservation of this important natural heritage, with its vegetation types and their associated biota already recognized as a priority for conservation in Espírito Santo. The state and municipal governments should encourage the creation of protected areas in the studied region, and these actions, along with environmental education programs and control of invasive exotic species, will ensure protection of the rich biodiversity found in this locality.

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LITERATURE CITED

APG (Angiosperm Phylogeny Group). 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society 181: 1–20. doi: 10.1111/boj.12385

Barbará, T., G. Martinelli, C. Palma-Silva, M.F. Fay, S. Mayo & C. Lexer. 2009. Genetic relationships and variation in reproductive strategies in four closely related bromeliads adapted to neotropical 'inselbergs': *Alcantarea glaziouana*, *A. regina*, *A. geniculata* and *A. imperialis* (Bromeliaceae). Annals of Botany 103: 65–77. doi: 10.1093/aob/mcn226

BFG. 2015. Growing knowledge: an overview of seed plant diversity in Brazil. Rodriguésia 66(4): 1–29. doi: 10.1590/2175-7860201566411

Brooks, T.M., R.A. Mittermeier, G.A.B. DA Fonseca, J. Gerlach, M. Hoffmann, et al. 2006. Global Biodiversity Conservation Priorities. Science 313(5783): 58–61. doi: 10.1126/science.1127609

Bremer, H. & H. Sander. 2000. Inselbergs: geomorphology and geoecology; pp: 7–35, in: S. Porembski & W. Barthlott (eds.). Inselbergs: biotic diversity of isolated rock outcrops in tropical and temperate regions. Berlin: Springer-Verlag.

Brummitt, R.K. & C.E. Powell. 1992. Authors of plant names. 1st ed. Kew: Royal Botanic Gardens 732 pp.

Burke, A. 2003. Inselbergs in a changing world—global trends. Diversity and Distributions 9(5): 375–383. doi: 10.1046/j.1472-4642.2003.00035.x

Caiafa, A.N. & A.F. Silva. 2005. Composição florística e espectro biológico de um Campo de Altitude no Parque Estadual da Serra do Brigadeiro, Minas Gerais – Brasil. Rodriguésia 56: 163–173. http://rodriguesia.jbrj.gov.br/FASCICULOS/rodrig56_87/12Caiafa.pdf

Christenhusz, M.J.M., X.-C. Zhang & H. Schneider. 2011. A linear sequence of extant families and genera of lycophytes and ferns. Phytotaxa 19: 7–54.

Conceição, A.A., A.M. Giulietti & S.T. Meirelles. 2007. Ilhas de vegetação em afloramentos de quartzito-arenito no Morro do Pai Inácio, Chapada Diamantina, Bahia, Brasil. Acta Botânica Brasílica 21(2): 335–347. doi: 10.1590/S0102-33062007000200008

Couto, D.R. 2013. Epífitos vasculares sobre *Pseudobombax* aff. *campestre* (Malvaceae) em complexos rupestres de granito no sul do Espírito Santo, Brasil [Masters thesis]. Jerônimo Monteiro: Universidade Federal do Espírito Santo.

Couto, D.R., V.C. Manhães, F.F. Campanharo & A.P.G. Faria. 2013. Checklist of the Bromeliaceae from Pedra dos Pontões, Mimoso do Sul, Espírito Santo, Brazil, with four first records for the state. Biota Neotropica 13(4): 113–120. doi: 10.1590/S1676-06032013000400012

Couto, D.R., H.M. Dias, M.C.A. Pereira, C.N. Fraga & J.E.M. Pezzopane. 2016. Vascular epiphytes on *Pseudobombax* (Malvaceae) in rocky outcrops (inselbergs) in Brazilian Atlantic Rainforest: basis for conservation of a threatened ecosystem. Rodriguésia 67(3): 583–601. doi: 10.1590/2175-7860201667304

D'Antonio, C.M. and P.M. Vitousek. 1992. Biological invasions by exotic grasses, the grass/fire cycle, and global change. Annual Review of Ecology and Systematics 23: 63–87. doi: 10.1146/annurev.es.23.110192.000431

Esgario, C.P., A.P. Fontana & A.G. Silva. 2009. A flora vascular sobre rocha no Alto Misterioso, uma área prioritária para a conservação da Mata Atlântica no Espírito Santo, Sudeste do Brasil. Natureza on line 7(2): 80–91. http://www.naturezaonline.com.br/natureza/conteudo/pdf/05_EsgarioCPetal_8091.pdf

Espírito Santo. 2005. Lista estadual da flora ameaçada de extinção. Decreto de Lei número 1.499-R de 13 de junho de 2005. Diário Oficial, Vitória, Espírito Santo, 14 de junho de 2005.

França, F., E. Melo & J.G. Miranda. 2006. Aspectos da diversidade da vegetação no topo de um *inselberg* no semi-árido da Bahia, Brasil. Sitientibus 6: 30–35.

Font Quer, M.P. 1977. Diccionario de botánica. Barcelona: Labor. 1244 pp.

Gomes, P. & M. Alves. 2010. Floristic diversity of two crystalline rocky outcrops in the Brazilian northeast semi-arid region. Revista Brasileira de Botânica 33(4): 661–676. doi: 10.1590/S0100-84042010000400014

Gomes, P. & M. Sobral-Leite. 2013. Crystalline rock outcrops in the Atlantic Forest of northeastern Brazil: vascular flora, biological spectrum, and invasive species. Brazilian Journal of Botany 36(2): 111–123. doi: 10.1007/s40415-013-0020-7

Gonçalves, E.G. & H. Lorenzi. 2007. Morfologia vegetal: organografia e dicionário ilustrado de morfologia das plantas vasculares. São Paulo: Instituto Plantarum de Estadudos da Flora. 416 pp.

International Plant Names Index [2017]. Accessed at http://www.ipni.org, 8 February 2017.

Larson D.W., U. Matthes U. & P.E. Kelly. 2000. Cliff ecology: patterns and process in cliff ecosystems. Cambridge: Cambridge University Press. 340 pp.

Leme, E.M.C., L.J.C. Kollmann & A.P Fontana. 2009. Two new species from Pedra dos Pontões, an unexplored mountain in Espírito Santo, Brazil. Journal of the Bromeliad Society 59(3): 152–169.

Manhães, V.C., D.R. Couto, F.D. Miranda & T.T. Carrijo. 2016. New findings on the distribution of *Pitcairnia azouryi* (Bromeliaceae), a species restricted to Atlantic Forest inselbergs. Phytotaxa 245(1): 59–65. doi: 10.11646/phytotaxa.245.1.6

Martinelli, G. 2007. Mountain biodiversity in Brazil. Revista Brasileira de Botânica 30 (4): 587–597.

Martins, C.R., J. Du V. Hay, B.M.T. Walter, C.E.B. Proença & L.J. Vivaldi. 2011. Impacto da invasão e do manejo do capim-gordura (*Melinis minutiflora*) sobre a riqueza e biomassa da flora nativa do Cerrado sentido restrito. Revista Brasileira de Botânica 34(1): 73–90. doi: 10.1590/S0100-84042011000100008

Martins, C.R., J.D. Hay, J.F.M. Valls, L.L. Leite & R.P.B Henriques. 2007. Levantamento das gramíneas exóticas do Parque Nacional de Brasília, Distrito Federal, Brasil. Natureza & Conservação 5(2): 23–30.

Mcneely, J.A., H.A. Mooney, L.E. Neville, P. Schei & J.K. Waage. 2001. A global strategy on invasive alien species. Gland/Cambridge: IUCN. 63 pp.

Mittermeier, R. & F. Scarano. 2013. Ameaças globais à biodiversidade de plantas; pp. 20–23, in: G. Martinelli & M.A Moraes (eds) Livro vermelho da flora do Brasil. Rio de Janeiro: Instituto de Pesquisas Jardim Botânico do Rio de Janeiro.

MMA (Ministério do Meio Ambiente). 2014. Portaria No 443, de 17 de dezembro de 2014 — lista nacional oficial de espécies da flora ameaçadas de extinção. Diário Oficial da União - seção 1, No 245, 18 de dezembro de 2014. Pp. 110–121.

Mori, S.A., L.A.M. Silva, G. Lisboa & L. Coradini. 1989. Manual de manejo do Herbário Fanerogâmico. Ilhéus: Centro de Pesquisa do Cacau. 104 pp.

Moro, M.F., V.C. Souza, A.T. Oliveira-Filho, L.P. Queiroz, C.N. Fraga, et al. 2012. Alienígenas na sala: o que fazer com espécies exóticas em trabalhos de taxonomia, florística e fitossociologia? Acta Botanica Brasilica 26(4): 991–999.

Nieder, J., J. Prosperí & G. Michaloud. 2001. Epiphytes and their contribution to canopy diversity. Plant Ecology 153: 51–63.

Oliveira, R.B. & S.A.P. Godoy. 2007. Composição florística dos afloramentos rochosos do Morro do Forno, Altinópolis, São Paulo. Biota Neotropica 7(2): 37–47. doi: http://doi.org/dc45fk

Pessoa, E. & M. Alves. 2014. Orchidaceae em afloramentos rochosos do estado de Pernambuco, Brasil. Rodriguésia 65(3): 717–734. doi: 10.1590/2175-7860201465311

Porembski, S., G. Martinelli, R. Ohlemuller & W. Barthlott. 1998. Diversity and ecology of saxicolous vegetation mats on inselbergs in the Brazilian Atlantic rainforest. Diversity and Distributions 4(3): 107–119. doi: http://doi.org/dfht7d

Porembski, S. 2007. Tropical inselbergs: habitat types, adaptive strategies and diversity patterns. Revista Brasileira de Botânica 30(4): 579–586.

Porembski, S. & W. Barthlott. 2000. Inselbergs: biotic diversity of isolated rock outcrops in tropical and temperate regions. Ecological Studies 146. Berlin: Springer-Verlag. 522 pp.

Prado, J., L.S. Sylvestre, P.H. Labiak, P.G. Windisch, A. Salino, et al. 2015. Diversity of ferns and lycophytes in Brazil. Rodriguésia 66(4): 1–11. doi: 10.1590/2175-7860201566410

Sardou Filho, R., G.M.M. Matos, V.A. Mendes & E.R.H.F. Isa. 2013. Atlas de rochas ornamentais do estado do Espírito Santo. Brasília: CPRM. 358 pp.

Simonelli, M. & C.N. Fraga. 2007. Espécies da flora ameaçadas de extinção no Estado do Espírito Santo. Vitória: IPEMA. 143pp.

Smith, A.R., K.M. Pryer, E. Schuettpelz, P. Korall, H. Schneider & P.G. Wolf. 2006. A classification for extant ferns. Taxon 55(3): 705–731. doi: 10.2307/25065646

Thiers, B. [2015]. Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. Accessed at http://sweetgum.nybg.org/ih/, June 2015

Zotz, G. 2013.The systematic distribution of vascular epiphytes — a critical update. Botanical Journal of the Linnean Society 171(3): 453–481. doi: 10.1111/boj.12010

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